A METHODOLOGY FOR ESTABLISHING BMC4I SYSTEM REQUIREMENTS AND CAPABILITIES

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This paper describes a developing process that includes a framework and methodology for use in establishing and resolving Battle Management , Command, Control, Communications, Computers and Intelligence (BMC^{4}I) Operational Architecture requirements and issues.

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BACKGROUND

This paper describes a developing process that includes a framework and methodology for use in establishing and resolving Battle Management Command, Control, Communications, Computers, and Intelligence (BMC4I) Operational Architecture requirements/issues. The purpose of this paper is to present the BMC4I requirements and capabilities that enable the achievement of improvements in joint warfighting battle management capability. The framework and methodology can be used as an analysis tool to examine how to overcome identified shortcomings in BMC4I systems, concepts, and doctrine; i.e., Tactics, Techniques, and Procedures (TTP). Technology, in support of current and future BMC4I system architecture developments, will continue to generate system architecture requirements that will upgrade BMC4I system capabilities and provide demonstrations of the upgraded BMC4I system performance.

INTRODUCTION

Joint system interoperabilities contribute the common system elements that support the execution of warfighting system functions. The goal of the framework/methodology process is to determine and furnish battle management requirements that support and export operational mission area capabilities. Figure 1, illustrates the four steps of the framework and methodology that develops, establishes and documents the joint interoperability requirements.
The figure shows:

Step 1. Defines functionality applicable to specific BMC4I functional areas.

Step 2. Employs live demonstrations, Modeling and Simulation techniques, and use of existing exercise data to verify and validate the generated BMC4I requirements.

Step 3. Reports the results of the BMC4I System demonstration exercises and models and simulations.

Step 4. If the results do not meet the requirements, develop additional BMC4I requirements and return to the testing process in Step 2.

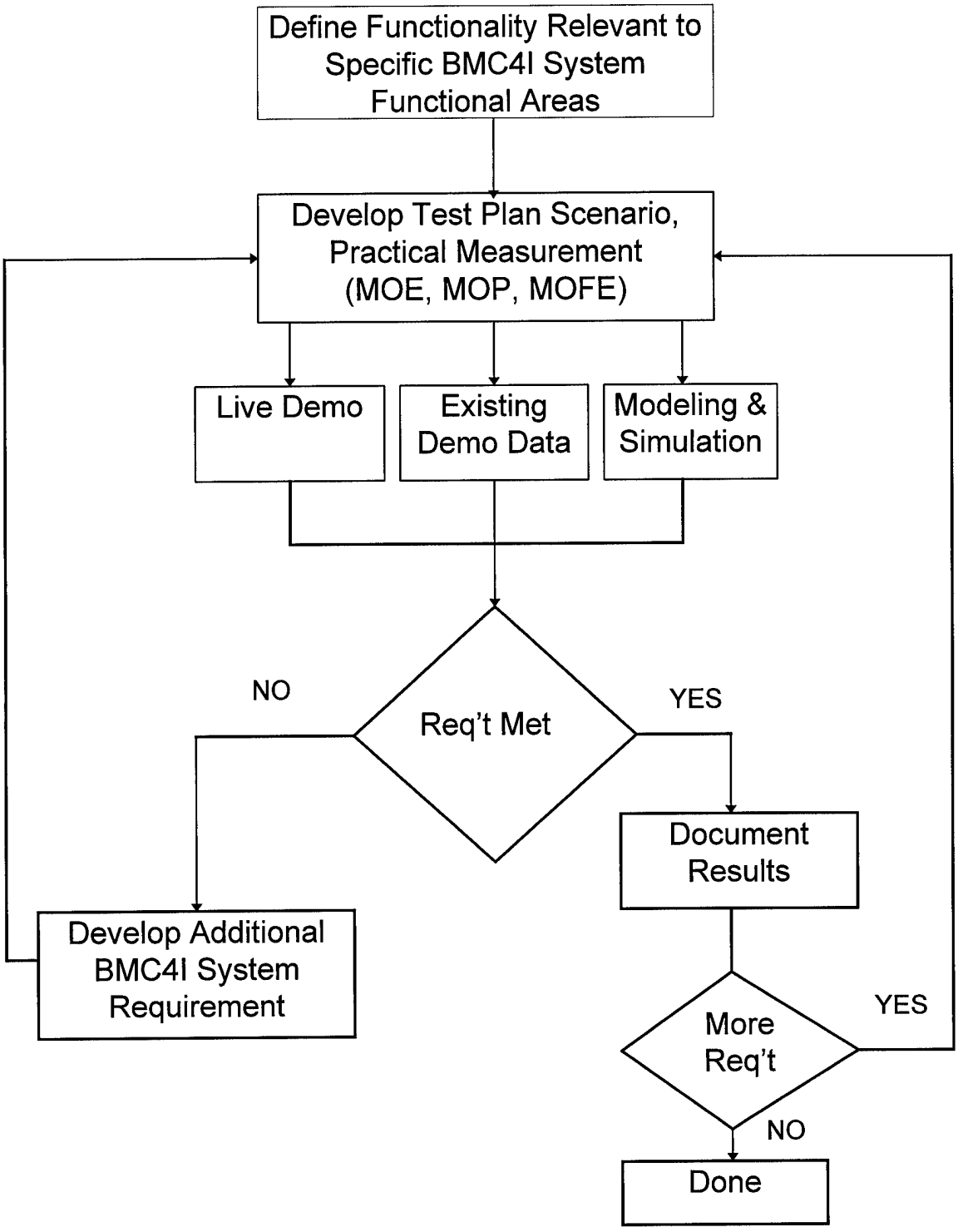

Figure 1
Methodology of BMC4I System Requirements

METHODOLOGY OVERVIEW

The methodology is based on the context of end-to-end BMC4I systems' ability to move, understand and act on information. Step 2 is the essentials of the methodology and is composed of the following three generic processes:

- Test Development Process that provides the scenarios,
- Pre-Analysis Process that generates test procedures,
- Exercise or Modeling & Simulation Process in which actual system interoperability data are collected.

The integration of these three processes constitutes the methodology's Test and Evaluation capability. It is assumed that the Exercises and Modeling & Simulation processes are not precise and values of the Data Elements obtained from the measures are relative values. The test execution of the three subprocesses produce battle management requirements and operational architecture capabilities.

DESCRIPTION OF CHARACTERISTIC REQUIREMENTS

The Exercise/Simulation Process of selecting criteria consists of three components. A scenario is developed that includes the details and accounts the Procedures, Pillars, and BMC4I Imperatives components in Figure 2. Table (1) lists the Pillars, Procedures, and BMC4I Imperatives categories. The procedure component provides the warfighting BMC4I operational for specific scenario procedures that are implemented in the actual demonstration exercises. It details the execution of the BMC4I requirements that implement the battle management and requirements capabilities.

PILLARS	PROCEDURES	BMC4I IMPERATIVES	
Single Integrated Air Picture	Monitor	Joint Weapons Deconfliction	Intelligence Preparation of the Battlespace
Early Detection/Combat ID	Assess	Unity of Command	Joint Engagement
Defense in Depth	Plan	Joint Weapons Allocation	Information Fusion
360 Degree Coverage	Execute	Graceful Degradation	Collaborative Planning
		Single Point Failure	Joint Interoperability
		Span of Control	Operational Flexibility
		Early Detection	Common Understanding
		Centralized Execution	Threat Prioritization
		Positive Identification	Distributed Battle Mgmt
		Decentralized Execution	Timely Assess & Warning
		Real-time, Near-real-time,	Non-real-time Data

Table (1)
Selection Characteristics Requirements

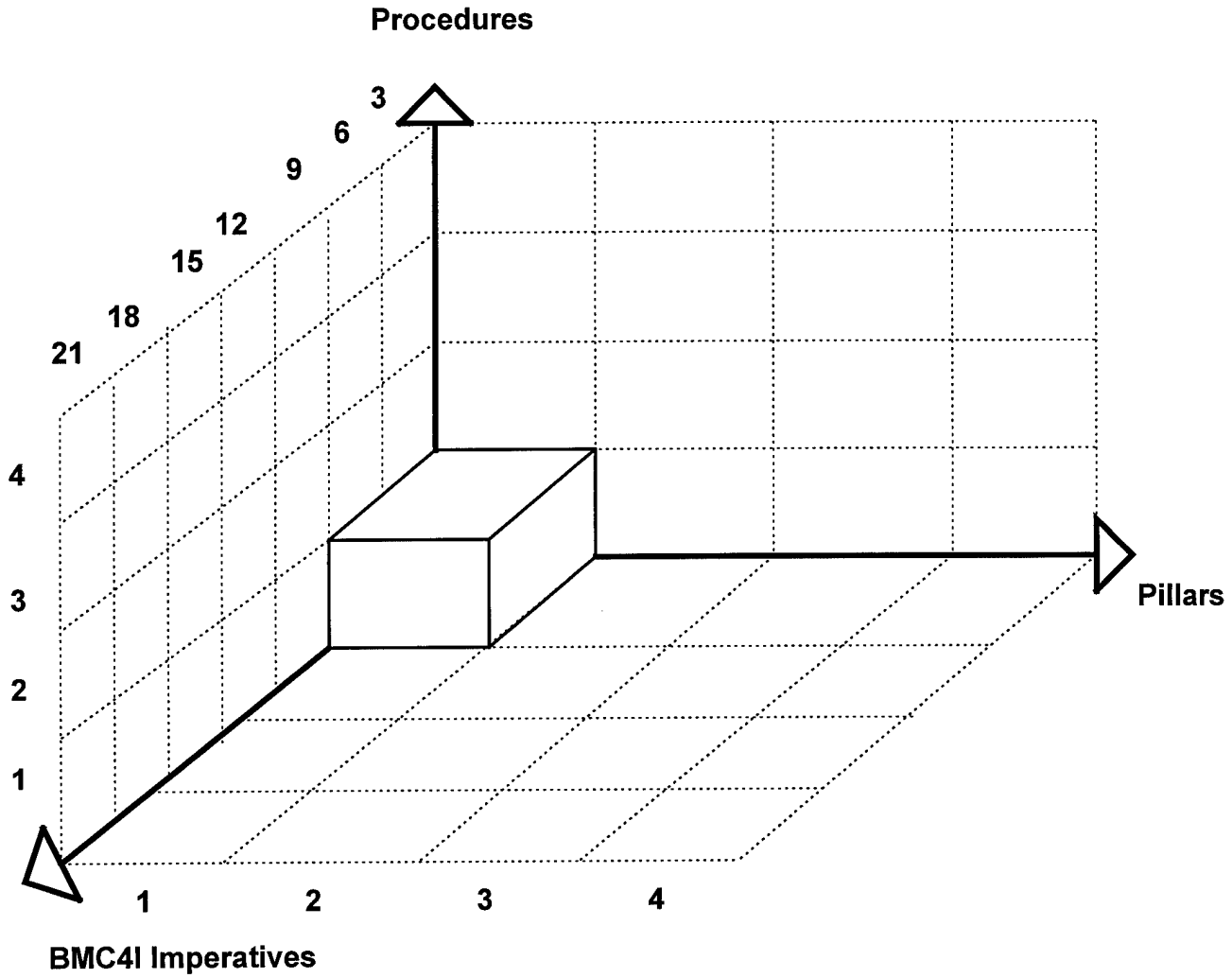

Figure 2
BMC4I Pillars, Procedures and Imperatives

Three levels of functional activities are involved in the procedures element. The levels of Activity are defined as Light, Moderate, and Heavy in Figure 3.

In the Light level the Warfighter monitors and analyzes the incoming operational data. The Warfighter determines if the situation is within the operational plan. The Warfighter continues with original plan. The quality of comprehension is high enabling the Warfighter to issue clear directions.

The Moderate level occurs when the Coherent Tactical Picture indicates the situation is outside the scope plan, but the Warfighter operates within scope of the contingencies. When good adaptive behavior is required the Warfighter operates faster than full cycle.

The Heavy level occurs when the operational data is misunderstood resulting in a situation with no contingencies. The Warfighter must be fast to salvage the mission.

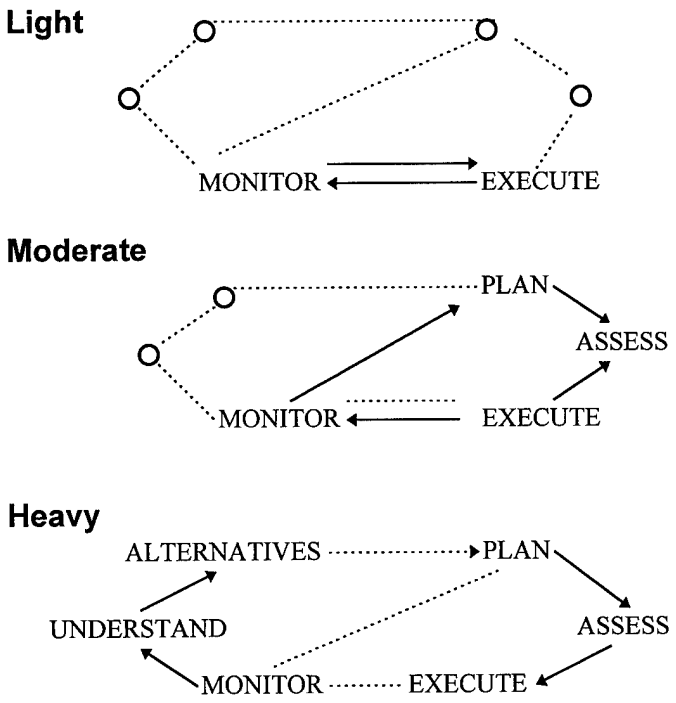

Figure 3
Levels Of Activity

Information Pools provide the characteristic information requirements for the implementation of the BMC4I capabilities. A Joint Information Pool is a collection of air defense related data elements and associated, aggregated information, which supports the performance of major subordinate functions in the joint air defense community. Information Pools implement BMC4I information requirements as they will involve a blending of centralized information repositories and distributed information repositories (databases), and data elements. The Information Pools concept is expected to be a valuable tool for the analysis and development of BMC4I operational system architectures capabilities. Information Pools can be defined sets or collections of information organized around major jobs in air defense such as, Intel preparation of the battlefield, target engagement, creating a recognized air picture, collecting ID information, or performing the airspace control function. There are twenty-one selections of characteristic BMC4I imperatives in the Information Pools.

BMC4I functions are derived from set information parts that specify functional procedures. Information Pools are used in Joint Data Network (JDN), Joint Planning Network (JPN), and Joint Composite Tracking Network (JCTN).

Infomation pools will be used is to continuously feed each other to achieve higher and higher levels of value. Information is moved from pool to pool, each time increasing the level of integration or aggregation. A processing center pulls information from the Detection sub pool, blends, and correlates it to establish a recognized air picture.

The set of notional Joint Theater Air Missile Defense (JTAMD) Information Pools are organized by eight categories on the network. They are identified in Table (2) as follows:
Surveillance, Airspace Control, Theater Air Defense (TAD) Intelligence, Identification, Weapon & Sensors Management, Joint Fire Control, Air Traffic Control (ATC), and Command.

Types of Information Pools							
Surveillance (S)	Airspace Control (C)	TAD Intel (I)	ID (D)	W&S Mgmt (M)	Joint Fire Control (F)	ATC (A)	Command (X)
1. Detection 2. Intercept 3. RAP	1. Control 2. Manage-ment	1. EOB 2. Real Time	1. Coop 2. Non Coop	1. Sensors 2. Weapons	1. Status 2. Engage-ment 3. Kill Assessment	1. Fl't Plan 2. Tracks	1. Orders/ Dir 2. Sum Rep'rts 3. Analysis

1,2,3 = subpools

Table (2)
Information Pools

The Surveillance Pool contains all information that contributes to establishing knowledge about the location, identity, and movement of objects in the aerospace environment. A subset of this information is certified to be best available and defines air situational awareness and a quality controlled single integrated aerospace picture.

The Airspace Control Pool contains information regarding friendly use of airspace. It is managed by the Airspace Control Authority, but is critically important to the air defenders. It is the source of joint information regarding friendly aircraft transit and safe passage corridors and routes, missile engagement zones, fighter engagement zones, joint engagement zones, altitude controls, and airspace assignments.

The TAD Intelligence Pool controls access to sensitive information. With emerging technology, several subpools could support with each at a different level of classification/sensitivity. A subset of information at the most sensitive levels could be authorized to be placed in the successively less sensitive pools, classification permitting.

The Identification Pool consists of information collected by friendly units (US forces and coalition partners) that can contribute to identifying airborne objects and/or classify them is information.

The Weapons & Sensors Management Pool is used for coordination among the sensor managers and operators, and the weapons managers and operators. It contains information on current sensor status and conveys orders to sensors from sensor managers.

The Joint Fire Control Pool (or Joint Engagement Coordination Pool) is intended to support the Theater Air Missile Defense (TAMD) community's need for coordinating and overseeing the engagement of enemy airborne threats. It would contain the fire control orders to subordinate weapon systems and provide information on what weapons are engaging what targets.

The Air Traffic Control Pool contains information from host nations or neighboring nations air traffic control systems. It includes commercial aircraft tracks and any other tracks that are being maintained of known nature/origin.

The Command Pool is defined to represent the repository of information that is broad in nature (e.g. commander's orders) or created by extracting information from several of the above pools through aggregation it into broader summary information. It includes a repository of past information presented to or requested by the commanders and senior officers at all levels of TAMD.

The shift to network-centric operations, enables the information intensive interactions between Warfighter nodes on the network. These interactions are focused on military operations in which infomation content, quality, and timeliness increases the Warfighter capability. As network quality approaches 100% relevant content, 100% accuracy, and zero time delay the Warfighter achieved information superiority. The shift from platform to network is what enables the more flexible and more dynamic network-centric operation. As an example, timeliness requirements for information exchange are stated in terms of non-real time, near-real time, and real time. Real time pertains to the timeliness of data or information that has been delayed only by the time for electronic communication. This implies that there are no noticeable delays. Near-real time pertains to the timeliness of data or information that has been delayed by the time required for electronic communication and automatic data processing. This implies that there are no significant delays. Non-real time is assumed to mean time greater than near-real time.

Four pillars have been established for JTAMD. They are a Single Integrated Air Picture (SIAP), Early Detection/Combat ID, Defense in Depth and 360 Degree Coverage. The Joint Chief of Staff defines the definition of the Pillars as follows:

SIAP is the product of fused, common, continuous, unambiguous tracks of all airborne objects in the surveillance area. By the Joint Theater Air & Missile Defense Organization definition of the Pillars, the SIAP is developed from near-real-time and real-time data and is scaleable and filterable to support situation awareness, battle management, and target engagements. The SIAP is the critical element that will give the Warfighter the ability to perform effective, efficient, and integrated TAMD utilizing advanced engagement concepts such as air-directed surface-to-air missiles and air-directed air-to-air missiles.

Early Detection is a function of land-air, sea, and space-based sensor placement and operation.

Defense in Depth refers to employing active air defense forces in a manner that provides multiple shot opportunities along the entire flight path or trajectory of a hostile aircraft or missile. In addition to improving effectiveness of the overall active air defense system, defense-in-depth seeks to engage air and missile threats at maximum range from defended assets.

Based on information, active air defense sensor and weapon positioning can be analyzed using the Joint Defensive Planner (JDP) to determine which laydown provides the best chance of Tactical Ballistic Missile (TBM) detection, tracking and engagement. Active air defense planning must account for worst-case, multi-threat, multi-axis attacks.

SAMPLE PROBLEM

Issue: Loading of the TADIL-J/LINK-16 networks under projected battle conditions.

Recommendation: (Non-Material) Make realistic assessments of the potential message loading of the TADIL-J/LINK-16 networks under projected battle conditions. Develop improved hierarchical structures and priorities for these messages, recognizing the inherent latencies that will be present in a realistic theater of LINK-16 platforms. Determine which messages can effectively be carried by LINK-16, considering latencies that will develop. Determine whether a reallocation of time-critical messages must be achieved in order to maintain the accurate SIAP needed for battle management and threat engagement.

Step 1 of the methodology requires definition of the functionality and relevant to specific BMC4I system functional areas. The specific issue selected in BMC4I area is loading of JDN TADIL-J messages. The methodology determines the example of JDN requirement for the loading of the TADIL-J/LINK-16 networks under projected battle conditions is as shown in Table (3).

CHARACTERISTIC	Joint Data Network (JDN) JTIDS Loading • Loading of the TADIL-J/LINK-16 networks under projected battle conditions.	
	IMPACT (Y/N)	DESCRIPTION/REQUIREMENT
Pillars		
Single Integrated Air Picture	Y	
Early Detection/Combat ID	Y	
Defense in Depth	Y	
360 Degree Coverage	Y	
Procedures or Tasks		
Monitor (Observe)	Y	
Assess (Understand SIAP)	Y	
Plan (Alternative Actions)	Y	
Execute (Decide and Direct Action)	Y	
BMC4I Imperatives		
Joint Weapons Deconfliction	Y	
Joint Weapons Allocation	Y	
Defense in Depth	(This imperative covered under "Pillars")	
Integrated Battlespace Picture	(This imperative covered under "Pillars")	
Early Detection	(This imperative covered under "Pillars")	
Positive Identification	(This imperative covered under "Pillars")	
Joint Engagement	Y	
Collaborative Planning	Y	
Joint Interoperability	Y*	
Operational Flexibility	Y	
Intelligence Preparation of the Battlespace		
Timely Assessment and Warning	Y	
Unity of Command		
Graceful Degradation		
[NO] Single Point of Failure		
Span of Control	Y	
Centralized Control		
Decentralized Execution		
Information Fusion	Y*	
Real-time, Near-real-time, Non-real-time Data	Y*	
Common Understanding		
Distributed Battle Management		
Threat Prioritization	Y	

Table (3)
Issue Selection Worksheet Sample

The scenario is based on the activity of the messages that are transmitted from producer over the network to the consumer. These messages reflect the level of the Light, Moderate, and Heavy battle management activity illustrated in Figure 3. When the tactical situation is well within operational plan the Warfighter monitors and executes the BMC4I operational plan as based on the messages transmitted and received over the JDN Network. However, when the situation is misunderstood the Warfighter must understand the evolving situation. The Warfighter transmits and receives the tactical information at a faster rate. The implication is that now there is more traffic on the network. The Warfighter is now operating at a higher tempo. The Warfighter is now required to find alternative actions that predict reasonable outcomes. From the list of reasonable outcomes, a selection is made and implemented as the required decision.

The measurements are made for events classified as Light, Moderate, and Heavy. Data for this example has been extracted from Reference 3, processed and is shown in the histogram of Figure 5, and provides the present of the result process data. Task Completed is defined as "information was sent and information was received and utilized". Task Not Completed is defined as "the data is received and found in error and not utilized."

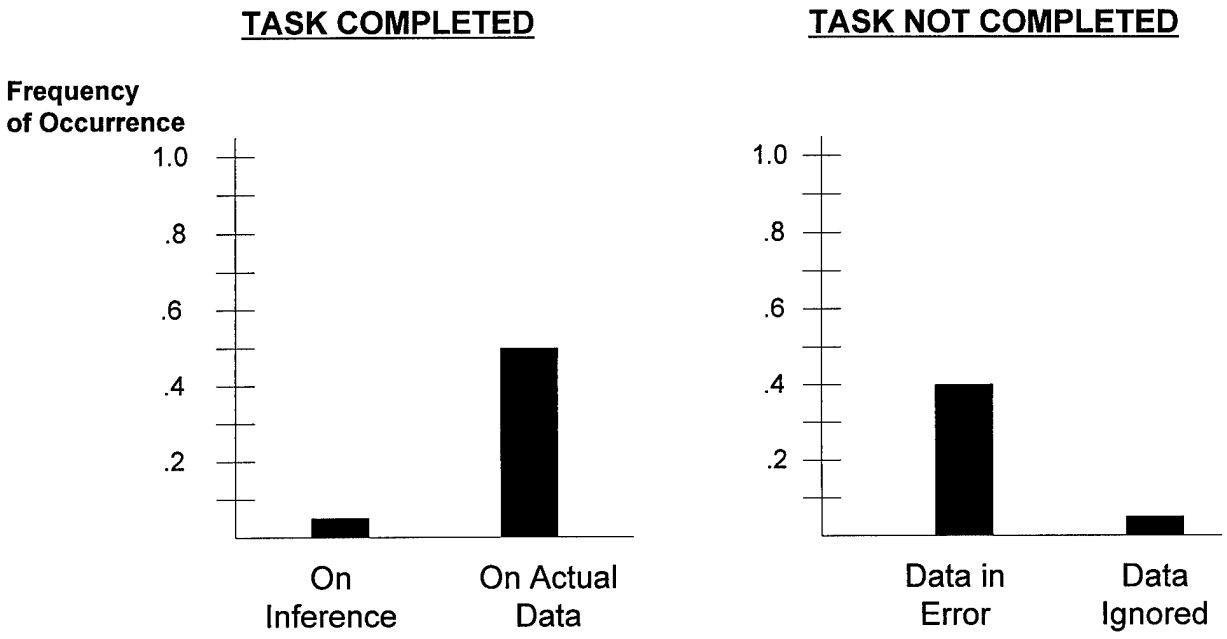

Figure 5
Procedures Element

SUMMARY

This paper presents the methodology for developing and setting BMC4I system requirements for the JDN. The sample selection worksheet has described a methodology for setting BMC4I system requirements and capabilities for a JDN requirement. The example presented demonstrated that the methodology enables the achievement of BMC4I improvements, enhances joint warfighting battle management capability, and establishes and the resolves BMC4I requirements.

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